RMA/IND-EMCAT-BFR-01F

Energy Audit Instruments: The Indian Market

January 1996

Prepared by: Niels R. Wolter
Resource Management Associates of Madison, Inc.
Madison Wisconsin, USA

and

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Indian Institute of Technology, Madras

Prepared for: United States Agency for International Development (USAID)
New Delhi, India
Contract Number:
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Preface

This report was completed under the Energy Audit Improvement Program component of the Energy Management and Consultation and Training (EMCAT) Project for India. EMCAT is funded by the U.S. Agency for International Development (USAID) for which Resource Management Associates (RMA) serves as the prime contractor for project implementation.

Under this portion of the Energy Audit Improvement Program, RMA is providing information concerning the Indian market for energy auditing instruments to both interested U.S. and Indian parties, with the intent of supporting U.S. business activities in India and encouraging Indian energy professionals to use energy auditing instruments (and promote energy audits) in their own country. Much of this information was gathered for the demand-side management component of the EMCAT project.

This is a working document published informally by RMA. This report has been prepared as a working document to present the activities and findings of our ongoing activities in a timely manner. Thus, it has received only light review. This document is being completed under the USAID-sponsored Energy Management Consultation and Training Project (EMCAT) for India. All opinions expressed in this report are those of the author and RMA.

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1. Executive Summary

With relaxing trade restrictions, a thriving economy, a growing middle class, and a population of 850 million, India has become one of the world=s most active markets. With economic reforms, business opportunities for U.S. firms are better now than in the last 50 years. Yet, India=s economic growth is hampered by a both severe energy shortage (primarily electricity) and the inefficient use of energy. India=s energy intensity could potentially be reduced by 20% to 40%. In order to address these inefficiencies, the wide-scale utilization of energy auditing instruments (EAIs) and energy audits are required. Yet, the use of EAIs by engineering consultants and industrial and commercial sector energy management staff is relatively low.

U.S., European, and Asian firms have been entering the India EAI market. Indian firms are looking to develop relationships with U.S. firms to support their efforts in producing EAIs. Although India is a challenging market for foreign firms to enter, barriers are falling, especially in the energy sector, where energy shortages and high energy prices are increasing the demand for energy audits. The time is ripe for U.S. firms to considered entering and developing their Indian EAI market.

This report reviews the current Indian business conditions, tax structures, and market barriers. A directory of 13 commonly used EAI types currently available in India is included. This directory is intended to describe some of the instruments available in India for U.S. EAI manufacturers interested in export to India and as a resource for Indian energy professionals interested in purchasing EAIs.

2. Introduction

The intent of this report is to promote the use of energy auditing instruments in India. This report will be useful to both U.S. EAI manufacturers, by informing them of the Indian market conditions, and Indian energy professionals, by providing them with a directory of the EAI available in India. It is hoped that this report will encourage U.S. manufacturers to enter the India market through licensing distributors, undertaking joint ventures, establishing subsidiaries, and opening production facilities. The report includes summaries of the following pertinent areas:

- Current status of EAI ownership by Indian engineering consulting firms
- Current business climate and tax structure in India
- Barriers present in the Indian EAI market
- How the commonly used EAIs operate and are applied
- Types, technical specifications, and costs of the EAIs available in India
- Addresses and contact names of some of the Indian firms currently manufacturing and distributing EAIs.

The secondary objective of this report is to inform Indian energy professionals (e.g., engineering firms, electric utility staff, consulting engineers, motor manufacturers and dealers, factory energy managers, engineering contractors, etc.) of the EAIs currently available in their country and their respective benefits.

It is not possible to present a thorough survey of all the EAIs currently available in India. Rather the AEAI directory@ provides examples of the EAIs which are currently available. The directory concentrates on the thirteen mostly common used EAIs as listed below: (Each of these instruments is included in the Energy Audit Instrument Directory.)

1. Anemometer
2. Combustion Analyzer
3. Ultrasonic Flow Meter
4. Humidity and Temperature Meter
5. Light Meter
6. Multimeter
7. pH Meter
8. Watt Meter, Power Meter, and Power Analyzer
9. Power Factor Meter
10. Ultrasonic Stream Trap Tester
11. Stroboscopic Tachometer
12. Infrared Non-Contact Temperature Sensor
13. Contact Thermometers.

3. Background

3.1 Energy Audit Tool Availability and Needs

Energy Audit Firms

In the fall of 1994, RMA staff met with and surveyed 59 Indian energy consulting firms to assess the availability of EAIs in India. These firms represent 59 of the 92 energy consulting firms approved by the Industrial Development Bank of India (IDBI). These firms should be among the best and most reputable in India.

Of the 59 firms, 40 claimed to have some type of EAI, while two firms claimed not to have any audit instruments (seventeen firms did not fill out the survey). The firms that do not have EAIs borrow them or use the instruments owned by the facility they audit. A summary of an EAI penetration survey based on the responses from the 40 energy consulting firms is presented in *Table 1*.

Table 1 Penetration of EAIs at Forty Indian Energy Consulting Firms

Energy Audit Instrument Type	Share of Firms with Instrument
non-contact temperature sensor	23%
combustion analyzer	38%
oxygen/combustion tester	35%
three-phase energy analyzer	30%
power analyzer/power meter	33%
multimeter	48%
contact thermometer	58%
ultrasonic flow meter	3%
ultrasonic steam trap tester	25%
stroboscopic non-contact tachometer	25%
anemometer	40%
light meter	50%
humidity and temperature sensor	38%
power factor meter	38%
watt meter	28%
computer	28%
mamometer	33%
tong tester	25%

There is not a single EAI that is owned by all or even most respondents. It is interesting that many consulting firms do not have the most basic EAIs required to complete a comprehensive audit. As shown in the EAI directory, each of these instruments types is available in India. Most firms purchase the minimum number of instruments they believe is necessary to complete their

work. This general lack of equipment ownership seems to be primarily due to limited funds rather than availability problems. Indian audit firms make do with instruments which are available to them. For example, they are known to use stethoscopes in place of ultrasonic steam trap testers.

Energy auditing is rather uncommon in India, compared to the U.S. or Western Europe. Because of the lack of demand for audits, audit firms' fees are relatively low. Thus, the firms do not have the funds needed to purchase and maintain a complete set of EAIs.

The engineering consulting firms surveyed were most interested in having access to common audit instruments rather than specialized instruments used for specific industrial applications.

Energy Buses

Indian EAI resources include 11 Aenergy buses@. The energy buses are equipped with all of the essential EAIs noted in Section 2, except for the ultrasonic flow meter and pH meter. The buses support the energy audit needs of a given city. The energy buses are sponsored by the European Community, the United Nations Development Project, and the Government of India (GOI). Buses are located in Pune, Bangalore, Kanpur/Calcutta (two), New Delhi (three), Madras, Rajkot, Bhopal, and Hyderabad. The Energy Management Center of India (EMC) intends to equip another 10 to 15 buses in the next two years. The energy bus program seems to be working well and is popular.

3.2 The Indian Business Climate [1]

India is a sovereign Socialist Secular Democratic Republic. The Indian economy has become more open than at any time since independence (1947). There are many opportunities for U.S. businesses to enter the Indian market or expand their activities and sales in India.

Indian Prime Minister Rao began the liberalization of the Indian economy during the fiscal year 1991/92. These reforms were driven largely by the intense lobbying of Indian business executives and seem to have the support of the general public. Reforms over the last four years have included Rupee convertibility, a rationalized and simplified tax structure, simplified import licensing, reduced customs duties, lowered personal and corporate taxes, and privatized public sector firms. These reforms, principally the gradual liberalization of the Government of India=s import policies, have been a boon to importers into India.

The maximum customs duty has decreased from 85% to 50%, with a minimum rate of 25%. The GOI plans to continue reducing import duties by 1997/98 to the level of 5% to 30% on industrial inputs and less than 50% for nonessential capital goods.

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[1] The section is largely based on information from reports of the National Trade Data Bank which is maintained by the US International Trade Administration.

Corporate tax rates for Indian firms have been reduced from rates of more than 50% downward to 40%. The tax rate for foreign companies has been reduced from 65% to 55%; but most foreign firms have Indian subsidiaries and thus pay the same tax rate as Indian firms.

The GOI provides "automatic approval" for foreign technology agreements (e.g., joint ventures) to ventures with up to 51% foreign equity participation. Hiring of foreign technical personnel and repatriation of profits and dividends is also allowed. One hundred percent export-oriented firms are allowed to import capital goods, components, raw materials, spares, and equipment duty free. They are also allowed to purchase domestically made capital goods, components, and raw materials without paying excise taxes.

Many Indian businesses are very interested in joint venture arrangements with U.S. firms, as well as British, German, Japanese, Korean, and other foreign multinational firms. To operate in India, foreign firms are required to have an industrial license and an investment proposal approved by the GOI. Import licenses are required for select items; these are issued by the GOI.

As a result of the economic liberalization of the last five years, the Indian economy is undergoing profound structural changes. Movement has been from an industrial policy of protected, government-owned and -operated and heavily regulated industries, toward the promotion of privatization and joint ventures with foreign firms, reduced government interventions (including subsidies), and general free market operation of the industrial sector.

As a result, some of the protectionist governmental structure remains during this transitory period. For example, many firms are still government owned and operated. Other firms are still receiving various forms of government subsidies. In general, the "small scale" manufacturers are more heavily subsidized than the larger firms.

Some major implications of these policy changes for U.S. businesses are the changes listed below:

- Increased investment opportunities (In fiscal year 1993/94, India attracted $US 5 million from portfolio and direct investments)
- Industrial and economic booms (Industrial output is anticipated to grow at a rate of as much as 10% to 15% annually for the next five years, while gross domestic product is increasing at a rate of 3% to 5% annually.)
- Reduced bureaucracy
- Improved market access
- Improved competitiveness of imported items
- Increased interest by Indian and non-Indian enterprises in joint ventures

- A growing middle class

- Increased financing opportunities for all sectors.

To keep pace with population growth (2% per annum) and relieve deficiencies in the existing infrastructure, the Indian economy will need to maintain double-digit growth rates for the next 15 to 20 years.

It is feared that without vigorous growth of the private sector, tax receipts will not meet budgetary needs and will result in deficit-driven inflation. To date, inflation has remained moderate; the current (first eight months of fiscal year 1994/95) annual inflation rate is 10.5%. Optimism in the markets, industrial growth, and better tax compliance is keeping inflation at bay. The rapid surge in money supply resulting from GOI expenditures and the large inflow of foreign capital have been supporting inflation.

Indian opposition parties have claimed that the reforms are a sell-out to multinational interests. There are populist fears that the Rao government is forsaking India=s economic sovereignty. As the success of the Indian economic reforms continue to provide real standard-of-living improvements, it is anticipated that the voice of the opposition parties will gradually be quelled.

U.S. firms interested in entering the Indian market are advised to participate in major trade fairs in India to demonstrate their products'/firm's capabilities to potential distributors and joint-venture partners. A directory of useful contact points for more information on the Indian business climate and business opportunities is included in Appendix 1.

3.3 Taxes

Taxes: Customs Tariffs

The GOI regulates imports through the Import Trade Control Organization, which is part of the Ministry of Commerce. The Import Trade Control Organization is headed by the Director General of Foreign Trade - New Delhi and Joint Chief Controllers who are stationed in Bombay, Calcutta, and other major Indian cities.

Customs or import tariffs on foreign-made goods have steadily fallen since the beginning of India=s economic liberalization in fiscal year 1991/92. The maximum customs rates are gradually being reduced to 50% for the FY 1995/96. At the same time, the minimum customs rate, which is applied to many imported electric devices and components, is also steadily declining to 25% for

[2] This does not include charges which were levied for storage and handling at the customs house. These

FY 1995/96. Tariff rates on EAIs imported to India by RMA in 1995 varied but averaged about 34%[2]. Tariff rates on general machinery (mechanical and electrical), machine tools, instruments, and projects were reduced 25% for FY 1995/96. Duties on electronic components and parts were 50% in FY 1994/95.

Typically, the GOI=s published custom tariff rates do not fully or accurately reflect the import charge because of numerous factors which a given tax assessor may or may not be aware of. For example, a package shipped via cargo may have a lower tariff assessment than a package shipped by courier. The tariff levied by the GOI at the port of arrival may be different from what the importer anticipated. Note also that tariffs are based on cost of the good plus the cost of shipping. Sources of information on Indian customs are listed in Appendix 2.

Taxes: Excise Duty

A large fraction of the GOI=s budget is raised by levying excise taxes on virtually all goods sold in India. The excise tax on EAIs is typically about 10%.

Taxes: State and Local Tariffs

State and local taxes are variable. As an example, in Ahmedabad in the state of Gujarat, the local tax rate in the city is 5% on all electric technologies, and the state sales tax is 4%.

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can account for an additional 5% to 15% cost increase.

3.4 U.S. Energy Audit Instruments Suppliers Active in India

Several U.S. energy audit instrument manufacturers are active in India (a partial list is included in *Table 2*). Our counterparts at the Indian Institute of Technology in Madras, were unaware of the presence of most of these firms in India even while they conducted an intensive search for such equipment. Thus, these firms may have a sales representative in India but may not be very active in the Indian market.

Table 2. U.S. EAI Suppliers and Manufacturers in India and the Availability of Equipment Servicing

Firm	Instrument Type	Sales Staff	Servicing
Bacharach	Combustion Analyzer	**U**	**U**
Fluke	Multimeters, etc.	**U**	**U**
Dranetz	Power Analyzers, etc.	**U**	**U**
Cole Palmer	Various	**U**	
Kurz	Anemometer	**U**	
Wahl	Temperature Sensors	**U**	
Monarch	Strobe Tachometers	**U**	**U**

3.5 Power Supply Specifications

Standard voltages and frequencies in India are 415 and 220 volts with a frequency of 50 cycles per second. Single- or three-phase connections are used. The most common ratings are 400, 220, 132, 66, 33, 11 and 6.6 kV (this refers to capacitors, fuses, and voltage regulators). India uses the metric system of weights and measures.

4. Barriers

4.1 Barriers Limiting the Penetration of Energy Audit Instruments

There are several barriers limiting the sales of EAIs in India. These barriers are similar to the problems encountered in most developing countries. Many of the barriers are currently being overcome, but much work toward reducing them remains. Many of the barriers listed below are based on the experiences of RMA staff in India[3].

High EAI Capital Cost:

- < Many Indian enterprises have limited financial resources. Often they operate off of cash flow, and are thus unable to hire energy audit firms or purchase EAIs.
- < Because of the lack of demand for audits, audit firms' fees are relatively low. Thus they often lack the funding needed to purchase and maintain a complete set of EAIs.
- < High customs duties on imported EAIs, or EAI components drive up their costs.
- < Because of the limited sales of EAIs, the economies of scale cannot be taken advantage of to reduce their costs.
- < No effective incentive programs have been instituted by the Indian government, utilities, or industrial associations to promote energy audits or reduce the cost of EAIs.

The Availability of High-Quality Energy Audits.

- < The number of trained energy auditors is relatively small considering the number of enterprises operating in India.
- < There is a shortage of energy audit tool sets in India.
- < Energy auditors awareness of potential energy conservation opportunities (ECOs) may be incomplete.
- < Many of the auditors lack the skills to effectively present their ECO recommendations.

EAI Servicing

- < Indian energy consultants claim to have difficulties receiving service and repair for their EAIs. Servicing can take from one week to three months for Indian-made instruments and up to six months for imported instruments.
- < Some energy consulting firms are unable to have their imported EAIs serviced.
- < Because of the long wait for servicing, many firms replace their EAIs rather than repairing or calibrating them. This expense dissuades firms from purchasing EAIs

[3] RMA has imported over $US 200,000 worth of US-made energy auditing instruments to India, provided energy audit training to 75 Indian energy professionals, conducted and supervised audits at 60 industrial and commercial enterprises, and worked closely with six Indian engineering/auditing firms.

unless they are considered an absolute necessity.

Customers: Awareness of the Benefits of Energy Audits.

- Potential audit sites are unaware of the potential energy savings an energy audit may reveal, and are often unwilling to have their facilities audited or implement recommended ECOs.
- Energy audits have not been effectively promoted by Indian engineering firms, government, utilities, or audit tool manufacturers.
- Successful audits and ECO implementations are not well publicized.
- There are no mandatory energy auditing or efficiency standards.
- Many industrial and commercial enterprise owners do not understand the basic principles of energy economics such as life cycle costs, payback period and internal rate of return. Nor do they understand the need for and benefits resulting from energy audits.
- Most industrial and commercial enterprises do not have energy management/engineering staff person(s) who would conduct energy audits or hire outside firms to conduct audits.
- Because of limited client demand the number of engineering firms providing audits is relatively small.

Tool Durability

- Transport of EAIs on motorcycles and motor scooters is common. Tools need to be durable to withstand jarring during transportation, dust, and high humidity
- Ideally, EAIs should provide trouble-free operation for long periods of time (because of the limited availability of spare parts, calibration, and maintenance). These requirements increase the cost of EAIs.

Tool Sophistication

- Many energy engineers are skeptical that highly sophisticated, imported EAIs can be serviced in India.
- Some auditors do not know if the sophisticated EAIs can be trusted, especially when their readings differ from those of their longstanding EAIs' measurements or the perceptions of factory engineering staff[4].

Importing EAIs and EAI components into India

- The customs rate assessment process is seemingly subjective, highly bureaucratic, and may result in long delays. For example, rate assessments can be based on the transportation mode used to import the equipment, or a written description of the equipment rather than a visual inspection.

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[4] In contrast other auditors feel that sophisticated EAIs are definitely more reliable and accurate.

- < It is difficult to obtain information from the GOI regarding current import duty rates.
- < General difficulties in communication with the import customs authority make it difficulty to effectively track goods through customs.

4.2 Recent Progress Toward Overcoming the EAI Barriers

The barriers listed above are becoming less significant. The recent changes in the economy, a serious and growing energy shortage, and rapidly increasing energy prices have been the primary reason for the increasing interest in energy audits and energy auditing instruments.

Electricity Price Increases
Over the last decade, electricity prices have been increasing more rapidly than general inflation. The industrial sector has been dealt a larger portion of the cost increases than any other sector. The average power tariff for the high-tension industrial sector is 2.5 Rupees/kWh (US$ 0.08/kWh). Commercial sector rates are 3.5 Rupees/kWh (US$ .12/kWh). High-speed diesel oil and furnace oil cost 240 and 180 Rupees/MMBTu ($US 7.80 to 5.90/MMBTu) respectively, while liquid propane gas costs 330 Rupees/MMBTU ($US 10.75/MMBTU).

These changes have the following impacts:

- C Encourage plant managers to take a close look at their energy consumption patterns and increase the priority of energy audits and audit instrument purchases

- C Increase interest in and demand for energy audits and EAIs

- C Reduce energy-efficiency investment payback periods

Because of the cost increases for fuel and power plant construction, many demand-side efficiency measures are now less expensive than supply-side options.

Electricity Shortages and the Indian Economic Boom:
India has long suffered under a shortage of electric power. Now, the economic boom is expanding the supply gap, and plant managers are less willing to accept power interruptions. It is estimated that the peak power deficit was more than 20% in 1994, reducing industrial output by about 5%. As a result, there has been a push to build new privately owned, utility-owned and captive power plants (operated by a factory to serve its own load) and to promote end-use energy efficiency (with an emphasis on the supply-side options).

A contract between the State of Maharashtra government and Enron Development Corporation to build the 695-MW Dhabol power plant was recently annulled and is only now being renegotiated. This delay will slow the rate of generation capacity growth and increase India's need and demand for energy audits.

Economic Reform
With the opening and vitalization of the Indian economy, more foreign producers of EAIs are entering the Indian market. The reforms under the Rao government have:

- Encouraged joint ventures between Indian and foreign firms and opened the market to multinational corporations, thereby promoting technology transfer and improving the availability and quality of EAIs.
- Gradually decreased customs and excise tariffs, thus increasing the competitiveness of foreign-made or -sourced EAIs and EAI components.
- Made banking, accounting activities more transparent.
- Reduced taxes on multinational firms.
- Greatly increased the rate at which foreign capital is entering India and increasing foreign currency reserves for foreign EAI or EAI component purchases.
- Ended the dual exchange rate system and improved the convertibility of the Rupee.

Not only is the economy growing, but so are the number of consumers. The Indian population is anticipated to surpass China's as the world=s largest market in the next century. Already over 200 million Indians are estimated to have a standard of living comparable to that of the U.S. and Canada. Foreign firms are aware of India=s huge market potential and are rapidly entering the India market, often with complete lines of products.

Availability of EAIs
As documented by the EAI directory (Section 5) many of the standard EAIs available in developed countries are now available in India. New manufacturers, and suppliers of EAIs are continually entering the Indian market.

Energy Efficiency Institution Building
The rapid energy price increases and energy shortages have created increased interest in demand-side management (DSM) at utilities, enterprises, and the GOI. Some utilities have begun taking the first steps toward incorporating DSM into their normal business practices. The GOI has formed institutions (e.g., the Energy Management Center [EMC], and the National Productivity Council [NPC]) to promote energy efficiency. Multinational organizations and other aid organizations have been providing training and technical support to begin DSM, integrated resource planning (IRP), energy pricing, engineering economics and energy audits. They are also providing energy auditing instruments and supporting demonstration projects. Some utilities such as Ahmedabad Electric Company (AEC) and the Bombay Suburban Electrical Supply (BSES) have recently instituted DSM programs. AEC is promoting industrial energy audits for their high-tension industrial customers. To date, AEC, with the support of three energy consulting firms, has completed about 20 walk-through audits and three detailed audits. In the coming year, the AEC audit program is anticipated to reach 15 to 20 high-tension industrial customers.

5. Energy Audit Instrument Directory

Explanation

The EAI types included in the directory were selected as a basic audit instrument set by RMA staff following discussions with Indian energy consulting firm personnel. RMA staff and a team at the Mechanical Engineering Department of Indian Institute of Technology - Madras attempted to identify all EAI manufacturers and suppliers and sent surveys to each identified manufacturer or supplier. Much of the information supplied by the firms surveyed was incomplete. All the specifications, cost quotes, and other relevant information that was provided are included in the directory. If more information is required, if specifications need to be clarified or if cost quotes are required, suppliers/manufacturers should be contacted directly.

5.1 Anemometers

Description:
Anemometers are essentially fluid flow measuring instruments. As energy audit tools, they are most commonly used to measure air flow from heating, ventilation, and air conditioning (HVAC) systems[5]. Anemometers are classified into four types:

- **Rotating Vane:** This instrument consists of a lightweight, fluid-driven vane, wheel or propeller, which is connected by a gearing system to a set of recording dials which display the amount of fluid passing through the wheel during a prescribed period. To compensate for the mechanism=s frictional drag at low fluid velocities, an **A** over-speeding@ gear train is often utilized. The over-speeding correction is usually additive at lower fluid velocities and subtractive at higher velocities.
- **Bridled Vane:** The velocity measurement made by this type of anemometer does not depend on a time interval. It measures the instantaneous velocity and head, then displays the velocity.
- **Deflecting Vane :** Instead of using a swinging vane to deflect the fluid flow and indicate a velocity reading, this instrument utilizes the pressure exerted on a vane. The deflecting vane is free to move in a circular tunnel and causes a pointer to indicate the velocity measurement on a scale. This type of anemometer is not dependent on fluid density because it senses pressure differentials to indicate velocities.
- **Hot Wire :** The hot-wire anemometer is employed to measure mean and turbulent velocity components. A fine wire is heated electrically and placed in the flow stream. The heat transfer rate from the wire is a function of flow velocity. In the more common constant-temperature version, the temperature of the wire is held constant through a suitable electrical circuit. Complete commercial versions of hot-wire and hot-film anemometers are available. These instruments are complex and relatively costly. In the U.S. they are commonly used for energy auditing.

Application:

Anemometers are most commonly used to measure the airflow of HVAC systems, but are also used to measure other clean air flows. For example, when testing and tuning a HVAC systems it is important to insure that appropriate quantities of fresh air are delivered.

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[5] Note, that no sources of pitot tube anemometers were identified during the investigation of energy audit instrument availability in India.

Hot Wire Anemometer

Supplier: Electronics International
P.B. No. 385, New No. 524
Sampige Road, Near 11th Cross
Malleshwaram, Bangalore 560 003
Phone: 91-80- 3340272 Fax: 91-80-3323357
Contact Person: Madhusudhan, Director of Sales

Technical Specifications: NETECH Hot Wire Anemometer
Measures air velocity, static pressure, temperature, air velocity (0 to 6,000 ft/min), pressure (0 to 5 inches of water), accuracy +/- 2%, rechargeable battery. High-temperature probes are not provided.

Price (provided Jan,9,95)
Netech Hot Wire Anemometer: Rs. 57,352

Comments: Manufactured by Netech of USA

Anemometer

Supplier: Trident Corporation
408, Sathy Road
Ganapathy, Coimbatore 641 006
Phone: 91-422-530527 Fax: 91-422-532155
Contact person: K. Chandrasekhar, Manager of Business Development

Technical Specifications :

Model	Description
#40	Maximum #40 anemometer with sensor terminal boot
#40H	Maximum #40 Hall Effect with sensor terminal boot
#40C	Calibrated maximum #40 with sensor terminal boot & calibration report
#200P	NRG wind direction vane with sensor terminal boot

Price Information :

Model	Price
# 40	Rs. 6,300
#40H	Rs. 7,450
#40C	Rs. 14,450
#200P	Rs. 11,500

Probe Anemometer

Supplier: Electronics International
P.B. No. 385 New No. 524
Sampige Road, Near 11th Cross
Malleshwaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357
Contact Person: Madhusudhan, Director of Sales

Technical specifications :

Model	Miniair 6 micro	Miniair 6 mini	Miniair 6 macro	
* Operating temperature	-10 to 80	-10 to 80	-10 to 80	(°C)
* Output signal	0 to 2.0	0 to 2.0	0 to 2.0	(volts)
* Minimum load	10	10	10	(kOhm)
* Probe length	165	175	225	(mm)

Comments: Manufactured by Schiltknecht Messtechnik AG., of Switzerland

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Thermoelectric (hot wire) Anemometers

Supplier: Electronics International
P.B. No. 385, New No. 524
Sampige Road, Near 11th Cross
Malleshwaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357
Contact Person: Madhusudhan, Director of Sales

Technical specifications :

* Flow measurement from 0.01 meters per second
* Two flow and two temperature measurement ranges
* Sensitivity increases towards zero, hence useful with 0-1 meter/second flows
* Applications: air conditioning, refrigeration plants, etc.

Comments: Manufactured by Schiltknecht Messtechnik AG., of Switzerland

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Hot Wire Anemometers

Supplier: UFA Marketing
S. V. Road
Manpada, Thane 400 607
Phone: 91-22-534-3361 and 534 3279 Fax: 91-22-534 6433
Contact Person: Pradeep Kumar Dubey, Sales Engineer

Technical specifications : Kurz Model 444 HT

* Velocity range 0 to 300 and 0 to 6,000 SFPM
* Duroflo probe, 13" long and 1/4" diameter
* Uses thermal sensors that automatically compensate for temperature and barometric pressure
* Sensor consist of platinum windings wound around a ceramic mandrel and coated with glass to assure a slick, no-stick surface.
* Rugged construction
* Includes one amp hour rechargeable NiCad cells
* Applications: air conditioning, refrigeration plants, etc.

Price (quoted Feb. 18, 1995): 121,500 Rupees

Other Suppliers of Anemometers

ACD Machine Control Company LTD
E 6, Udyog Sadan
2, MIDC, Anderi
Madras 600 002

Lawrence and Mayo (I) PVT. LTD.
Scientific and Engineering Instruments Division
68, Anna Salai
Madras 600 002
Phone: 91-44-83-0312 and 83-0313

5.2 Combustion Analyzers and Other Combustion Gas Monitoring and Control Instruments

Description:
A combustion analyzer estimates the combustion efficiency of furnaces, boilers and other fossil fuel-fired devices. To estimate efficiency, the instrument measures the composition of the flue gas (typically CO_2, CO and O_2) and exhaust gas temperature. Oxygen levels are measured to ensure proper excess air levels. Each furnace design and fuel type has an optimal excess air level.

Two general procedures are used to determine combustion efficiency: a manual process through the Orsat procedure, or use of a (computerized) combustion analyzer. The combustion analyzer estimates efficiency by performing the concentration and temperature measurements and completing the necessary calculations to determine efficiency. The manual procedure, or Orsat method, requires the auditor to measure flue gas temperature and the concentrations of CO_2 and O_2, then calculate (or obtain from standard charts) the combustion efficiency.

The Orsat procedure provides an instantaneous measurement of the combustion products, while a combustion analyzer provides a continuous measurement of the combustion products. Continuous measurement allows for trending of combustion products as boiler load changes and as boiler adjustments and improvements are made. The Orsat procedure is relatively difficult and prone to human error.

A combustion analyzer requires a probe for stack measurements. The probe is inserted through a single stack or breathing hole to measure combustion product concentration and flue gas temperature.

Combustion testing is used to gauge if the appropriate amounts of combustion air for efficient fuel combustion are being maintained in the boiler/furnace/kiln. Low CO measurements are indicative of excess air, whereas high CO concentrations are indicative of low oxygen or poor burnout conditions. Similarly, high stack temperatures (and thus high rates of heat loss) are indicative of excess air (O_2).

Many of the combustion analyzers are also able to measure the concentrations of SO_2, NO_x , and soot, making these instruments valuable for measuring combustion air pollutant emissions. The typical range of concentration, measured by combustion analyzers in the flue gases, is 0% to 21% for O_2; from 0% to 20% for CO_2; and between 0% and 0.5 % for CO.

Application:
Combustion analyzers can be used for periodic combustion tuning of furnaces, boilers, and kilns and to insure optimal fuel combustion. Using a combustion analyzer to regularly maintain combustion efficiency can have a payback period of weeks to months for larger furnaces. For example, a 1% O_2 reduction can result in 2% fuel savings.
Comments:

Oxygen sensors used by combustion analyzers typically have a shelf life of about six months and cost about Rs. 7,500 ($US 240).

Combustion Analyzer

Suppler: ACE Gas Analyzers PVT. LTD.
1,Biradari
M.G.Road
Ghatkopar (W), Bombay 400 086
Phone: 91-22-512-5153 and 516-8973 Fax: 91-22-516-8973
Contact person: A. K. Shah

Technical specifications :

* Sensors are electrochemical cells
* Sensors are suitable for temperatures up to 760^{o}C
* Semi automatic analyzer calibration
* Oxygen indicator accuracy: 0.1% +/- 5% per reading
* Oxygen level helps in fuel savings
* Also measures CO, CO_2, NO_x and SO_2.

Combustion Analyzer

Supplier: Alacrity Electronics LTD.
15, Thirumalai Road
T. Nagar, Madras 600
Phone: 91-44-825-1771 Fax: 91-44-825-9406
Contact person: D. S. Dwarkanath, Executive Sales Engineer

Technical specifications :

* Measure O_2, CO, and net temperature
* Temperature presented in centigrade and Fahrenheit
* O_2 sensor: self-powered, diffusion-limited, metal air battery
* Carbon sensor: micro fuel cell

Comments: Manufactured by Kane-May (I) LTD., of the U.K.

Combustion Analyzer

Supplier: Netel Chromatographs
S.V. Road
Manpada, Thane 400 607
Phone: 91-22-534-3279, 534-3361 and 534-4721 Fax: 91-22-534-6433 and 208-2113

Technical Specifications: Model IMR 1200 P

* Portable microcomputer-based unit able to continuously analyze O_2, CO, CO_2, combustion efficiency, lambda, soot, chimney drought, air inlet temperature, and exhaust gas temperature
* Line-powered 220V/50Hz, or by battery.
* Includes 300 mmlg. gas sampling probe with NiCrNi jacket thermocouple
* Continuous measurement of all variables and simultaneous display of two, free programmable variables

Prices (valid through Feb/4/95):

Combustion Analyzer: Model IMR 1200 P	$US 6,000	Rs. 185,000

Comments:

Distributor is a division of Universal Ferro & Allied Chemicals LTD
Combustion Analyzer manufactured by IMR GmbH of Germany

Combustion Analyzer

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact person: Madhusudhan, Director of Sales

Technical Specifications: TEMAC Model 3004
* Portable microcomputer based unit
* Analyzes O_2, CO, NO, SO_2, combustion efficiency, percent oxygen, and temperature (0^oC to 600^oC)
* Line-powered 220V/50Hz, or by battery
* Includes 48-inch sampling probe

Price (provided Jan,9,95)

TEMAC Model 3004 Flue Gas Analyzer	Rs. 275,451

Comments: Manufactured by TEMAC of Denmark

Combustion Analyzer

Supplier: M. K. Raju Consultants (PVT) Ltd.
16, Srinagar Colony
Temple Ave.
Madras 600 015
Phone: 91-44-235-2491 and 235-1151 Fax: 91-44-235-1070

Technical Specifications:

Technical specifications: Pocket 100
* Measures O_2, (range 0 - 25%, accuracy 0.2%), CO (range 0 -2,000 ppm, accuracy 5%) CO_2 (range 0 - 20%, accuracy 0.3%) and temperature (0 °F - 2,000 °F)
* Sensor: Oxygen disposable galvanic - 6-month guarantee, CO electrochemical - 12-month guarantee; Temperature: type-K thermocouple.
*Pocket-sized

Comments:
* Manufactured by Energy Efficiency Systems Inc. of the US
* Raju Consultants is a consulting firm which is willing to provide customers with auditing equipment

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Combustion Analyzer

Supplier: M. K. Raju Consultants (P) LTD
16, Srinagar Colony
Temple Ave.
Madras 600 015
Phone: 91-44-235-2491 and 235-1151 Fax: 91-44-235-1070

Technical Specifications:
Technical specifications: ENERAC 2000
* Measures:
- O_2 using electrochemical cell (range 0 - 25%, accuracy 0.2%)
- NO_x (optional) using electrochemical cell (range 0 - 2,000 ppm, accuracy 5%)
- CO using electrochemical cell (range 0 -2,000 ppm, accuracy 5%)
- SO_2 (optional) using electrochemical cell (range 0 - 2,000 ppm, accuracy 5%)
- Combustibles (gaseous) using semiconductor sensor (range 0 - 2.5%, accuracy 10% of reading in CH_4 gas)
- Ambient temperature using IC sensor (0 °F - 150 °F, accuracy 3 °F)
- Stack temperature using Type K thermocouple (0 °F - 2,000 °F, accuracy 5 °F)
- Draft using piezoresistive sensor (range 10 to 40 inches water, accuracy 5% of reading)
- It also measures smoke (using smoke spot method) and time and date
* Sensors: O_2 has and 12-month life and NO_x , CO, and SO_2 have 2-year life.
* Computes: Combustion Efficiency, Carbon Dioxide, Excess Air, and Emissions Units
* Portable
* Has RS-232 port and 1,200 baud auto-answer modem
* Options include printer and microcomputer for data storage
* Operates with any fuel

Comments:
* Manufactured by Energy Efficiency Systems Inc. of the US
* Raju Consultants is a consulting firm which is willing to provide customers with auditing equipment

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Combustion Analyzer

Supplier: Telegan Instruments (India) Pvt. LTD.
Kalash, New Sharda Mandir Road
Ahmedabad 380 007
Phone: 91-79-431-633 and 431-635 Fax: 91-79-431-160
Contact person: B. Santharam

Technical Specifications: TECO - multifuel combustion analyzer

* Two-digit display of O_2 (range 0 - 20.9%, accuracy 0.1 +2%) and CO (range 10 - 1999 ppm, accuracy +/- 5%) concentration in mode 1, and gas temperature
* Gas temperature (range 0 - 450 ^oC, accuracy +/- 3%) and combustion efficiency is displayed in mode 2
* CO_2 indication (range 0 - 20%, accuracy +/- 5%) and five fuel selection (natural gas, LPG, light fuel oil, heavy fuel oil, and coal)
* O_2 and CO sensor cells have a life of 2 years, guaranteed for 1 year.
* 185 mm probe
* Electrochemical sensors
* RS232 output
* Eight hours continuous battery operation

Technical Specifications: SONOX- microprocessor-based combustion analyzer

* Measures NO (1 - 2,000 ppm), NO_2 (0 - 2,000 ppm), NO_x (0 - 4,000 ppm), O_2 (0 - 20.9%), SO_2 (0 - 2,000 ppm)
* 208 mm glass-lined probe
* RS 232 output for printing/logging
* Includes standard accessories
* Continuous measurement of all variables and simultaneous display of two, free programmable variables

Prices (quoted Feb. 13, 1995):

TECO	Multifuel combustion analyzer	Rs. 103,500
	Program change for fuel type	Rs. 45,000
	Printer 170	Rs. 46,300
SONOX		Rs. 145,770

Comments:

Manufactured by Telegan Instruments of England

Combustion Analyzer

Suppler: Technovation Analytical Instruments PVT. LTD.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050

Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D=Sylva, Chief executive

Technical specifications: Mini-Oxygen Meter Model EC3

* Includes pump required to draw flue gases through unit
* Power source: rechargable Ni/cd battery pack, with low battery indicator
* Unit operating temperature: 5 to 50ºC
* Sensor is electrochemical and has a 12-month life
* Sensors are suitable for temperatures up to 450ºC
* Range: 0 to 25% oxygen with 0.1% steps
* Oxygen indicator accuracy: +/- 1% of reading at constant temperature
* Response time: less than 10 seconds
* Calibration by ambient air
* Size: 130 x 65 x 65 mm, 500 grams

Comments: Manufactured in India

Combustion Analyzer

Suppler: Technovation Analytical Instruments PVT. LTD.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050
Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D=Sylva, Chief Executive

Technical specifications: Mini-Carbon Dioxide Meter

* Includes pump required to draw flue gases through unit
* Power source: rechargable Ni/cd battery pack, with low battery indicator
* Unit operating temperature: 5 to 50ºC
* Display is 12 mm LCD 3 **2** digits
* Sensor is electrochemical and has a 24-month life
* Sensors are suitable for temperatures up to 450ºC
* Range: 0 to 2% carbon dioxide with 10 ppm steps standard (units with 0-1999 ppm range with 1 ppm step are available on request)
* CO indicator accuracy: +/- 2% of reading at constant temperature
* Response time: less than 40 seconds
* Calibration using CO calibration gas
* Size: 130 x 65 x 65 mm, 500 grams

Comments: Manufactured in India

Combustion Analyzer

Suppler: Technovation Analytical Instruments PVT. Ltd.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050
Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D=Sylva, Chief Executive

Technical specifications: Percent Oxygen and Temperature Indicator: Model OTI

* Includes pump required to draw flue gases through unit
* Power source: rechargable Ni/cd battery pack, with low battery indicator
* Unit operating temperature: 5 to 50°C
* Display is 12 mm LCD
* Oxygen sensor is electrochemical and has a guaranteed 12-month life
* Temperature sensor is a Cr/Al thermocouple with a 0 - 600°C range
* Range: 0 to 2% oxygen with 0.1% steps and
* Oxygen indicator accuracy: +/- 2% of reading +/- 0.1% step
* Temperature indicator accuracy: +/- 1% relative with 1°C steps
* Probes are suitable for temperatures up to 600°C
* Probe length: 600 mm
* Response time: 20 seconds for temperature and 5 seconds for oxygen content
* Calibration by ambient air
* Size: 210 x 150 x 60 mm, 1,500 grams

Comments: Manufactured in India

Combustion Analyzer

Suppler: Technovation Analytical Instruments PVT. Ltd.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050
Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D=Sylva, Chief executive

Technical specifications:Fluegas Monitor for Oxygen and Carbon Dioxide Model: FGM

* Portable
* Includes pump required to draw flue gases through unit
* Power source: 220 VAC/50 Hz, Ni/Cd rechargeable batteries
* Gas flow rate: 50 liters per hour
* Unit operating temperature: 5 to 50°C
* Display is 12 mm LCD 3 **2** digit
* Oxygen sensor is fuel cell with a 12-month life
* Range: 0 to 25% oxygen with 0.1% steps

* Oxygen indicator accuracy: +/- 1% of signal at constant temperture with +/- 0.1% O_2 step
* Oxygen sensor calibration using ambient air
* Carbon dioxide sensor is electrochemical with a life of 24 months
* Carbon dioxide standard range of 0 - 2% CO
* Accuracy: +/-2% of reading at constant temperature
* Calibration by calibration gas
* Probes are suitable for temperatures up to 600ºC
* Probe length: 4-meter copper tube
* Response time: 90% in 30 seconds
* Size: 192 x 192 x 240 mm, 4,600 grams

Comments: Manufactured in India

Combustion Analyzer

Suppler: Technovation Analytical Instruments PVT. Ltd.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050
Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D-Sylva, Chief Executive

Technical specifications:Fluegas Monitor for Oxygen, Carbon Dioxide and Temperature Model: TCM
* Portable
* Includes pump required to draw flue gases through unit
* Power source: 220 VAC/50 Hz, Ni/Cd rechargeable batteries
* Gas flow rate: 50 liters per hour
* Unit operating temperature: 5 to 45ºC
* Oxygen sensor is electrochemical with a 12-month life
* Range 0 to 25% oxygen in 0.1% steps
* Oxygen indicator accuracy: +/- 2% of reading at constant temperture
* Oxygen sensor calibration using ambient air
* Carbon dioxide sensor is electrochemical with a 24-month life
* Carbon dioxide standard range of 0 - 2% CO, optional 0-10% range with 100 ppm resolution
* Accuracy: +/-2% of reading at constant temperature
* Calibration by calibration gas
* Temperature sensor is the Cr/Al thermocouple
* Temperature range: up to 600ºC, optional to 1,100ºC
* Probes are suitable for temperatures up to 600ºC, optional 1,100ºC
* Probe length: 4-meter copper tube
* Size: 43 x 32 x 12 cm, 6,000 grams

Comments: Manufactured in India

Combustion Analyzer

Suppler: Technovation Analytical Instruments PVT. LTD.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050
Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D-Sylva, Chief Executive

Technical specifications: Dual-Purpose Combustion and Pollutant Monitor Model: TFGA

* Portable
* Warm up time: two minutes
* Response time: 45 seconds
* Includes pump required to draw flue gases through unit
* Power source: 230 VAC/50 Hz, Ni/Cd rechargeable batteries
* Unit operating temperature: 5 to 45°C
* Operating relative humidity: 0 to 99%
* Display: two 3 **2** digit 12 mm LCDs
* Probe length: 6-meter copper tube
* Size: 192 x 192 x 300 mm, 6,500 grams
* Gas readings by selector switch
* Measures concentrations of O_2, CO, NO, NO_2 and SO_2
* All sensors are electrochemical, two year expected life
* Sensor accuracy +/_ 2%

	$\%O_2$	%CO	CO	NO_2	SO_2	NO
Digital display ranges	0-25	0-2	0 - 1999ppm	0 - 1000ppm	0 - 1999ppm	0 - 1999ppm
Resolution in steps	0.1%	0.001%	1 ppm	1 ppm	1 ppm	1 ppm

Comments: Manufactured in India

Other Suppliers of Combustion Analyzers

L G Balakrisknan & Brothers Ltd.
Instrumentation Division
12, Mc Nichols Road
Chetpet, Madras 600 031

Rosemount (I)
1A, Nungambakkam High Road
Chepet, Madras 600 031
Phone: 91-44-826-0117, 826-0121 and 827-6252

Bacharach, Inc.
JNM Systems and Services Pvt. LTD.
P.B. No. 29
Bombay Poona Road
Kasarwadi, Poona 411 018
Phone: 91-212-83495
Fax: 91-212-777-413
Contact Person: Sachin Shah

Combustion Gas Control System

Supplier: Fykays Engineering PVT. Ltd.
10/11, Subhash Road
Jogeswari (East), Bombay 400
Phone: 91-22-837-8678, 837-8679 and 837-9267 Fax: 91-22-837-8754
Contact person: Miss Iyengar, Sales Executive

Technical specifications:

* Non-portable
* Microcomputer systems for atmospheric and combustion control
* Uses a zirconia *in situ* probe as the signal source
* Normally used with temperatures of 750°C
* Reads O_2%, carbon potential, dew point, etc. directly
* CAD/CAM technique ensures high intrinsic accuracy and stability
* Continuous precision control
* Mounted at boilers, rotary kilns, furnaces, etc.

Combustion Gas Control System

Supplier: Raskin Oxygen Probe Systems
B-36, Subhadra Park Society
Behind Utkarsh Vidyalaya
Baroda 390 015
Phone: 91-265-323-009 and 320-930 Fax: 91-265-339-84
Contact person: R. M. Chandwani

Technical specifications:

* Non-portable
* Oxygen probes for monitoring excess air and optimizing air flow in boilers, furnaces, kilns, etc.
* Accurate measurement near the point of combustion is possible
* Instantaneous response (<1 second) thus tighter control
* Design to withstand temperatures in the range of 600 - 1,400 ^{o}C
* Measurement range: 0.2 to 20%, 0.1 to 10 %, or 1 to 1,000 ppm O_2

Combustion Gas Test Kit

Supplier: Forbes Marshall Group
Bombay-Pune Road
Kasarwadi, Pune 411 034
Phone: 91-212-773-495 Fax: 91-212-777-413
Contact person: K. A. Parvin, Research and Development Engineer

Technical specifications :

* The set consists of a spot smoke test kit and flue gas thermometer
* Smoke tester good for 500 tests, contains 40 filter strips
* Draught gauges for smokeless boiler operation
* Indispensable for adjusting firing rate, flame, and locating air lines
* O_2 indicators are the best substitute for the time-consuming Orsat procedure

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5.3 Ultrasonic Flow Meters

Description:
Ultrasonic flow meters are used to estimate fluid flow without having to penetrate piping. Ultrasonic flow meters operate based on one of two methods. Some use the the frequency shift (i.e. Doppler effect) experienced by an ultrasonic signal as it is reflected by bubbles or particles (i.e., discontinuities) entrained by a flowing fluid. The magnitude of the frequency shift is indicative of the velocity of the fluid. Other ultrasonic flow meters are able to estimate the velocity of a clear (i.e., free of entrained particles or bubbles) liquid. Given the inside pipe diameter, the instruments then calculate flow rate (i.e., gallons/minute or liters/minute). Ultrasonic flow meter measurements can be relatively inaccurate.

Application:
Ultrasonic flow meters can be used to estimate flow rates entering or leaving a pump. For example, the instrument can be used to ensure that flow rates are maintained as efficiency improvements (i.e., reducing motor size, and re-plumbing to reducing frictional losses) are made to plumbing systems.

Comments:
Based on a survey of 40 energy consulting firms completed by RMA staff, more than half of the respondents commented that the most difficult EAI for them to purchase is a reliable ultrasonic flow meter. India audit engineers commented that imported ultrasonic flow meters are difficult to find and are prohibitively expensive.

These instruments are not made in India.

Ultrasonic Flow Meter

Supplier: CDCON
B-1, Shantivilla Apartments
Pratapkunj Society
Vasna, Ahmedabad 380 007
Phone: 91-272-432-397 and 430-70 Fax: 91-272-432-397
Contact person: D. K. Soni

Technical specifications:

* Output: 4-20 MA into 600 Ohms max.
* Weight: 16 lbs. with transducers
* Temperature range: 0 to 50°C
* Power: Self-contained battery with recharger or 120 VAC
* Flow rate range: 8 digit LCD, in GPM, MGD, FPS or metric equal 0.2 FPS to 20 FPS

Price Information: Rs.201,500

Ultrasonic Flow Meter

Supplier: CDCON
B-1, Shantivilla Apartments
Pratapkunj Society
Vasna, Ahmedabad 380 007.
Phone: 91-272-432-397 and 430-70 Fax: 91-272-432-397
Contact person: D. K. Soni

Technical specifications :
* Size: 10" x 4" x 9"
* Weight: 6 **2** lbs.
* Temperature range: -20 to 60ºC
* Repeatability: +/- 1%

Price Information: Rs. 68,200

Ultrasonic Flow Meter

Supplier: Netel Chromatographs
S.V. Road
Manpada Thane 400 607
Phone: 91-22-534-3279, 534-3361 and 534-4721 Fax: 91-22-534-6433 and 208-2113

Technical Specifications: Model M31-902
* Portable microprocessor-based
* Keypad for data entry
* Reads directly in metric engineering units selected by entering pipe I.D.
* Output: 4 to 20 MA
* Self-contained battery and charger for up to 10 hours of operation
* Includes two T-903 transducers with 20 feet of retractable cable

Prices (valid through Feb/4/95):

Ultrasonic Flow Meter: Model m31-903	$US 7,150
* 8 digit LCD reset counter	$US 220
* Thermostatically controlled heater	$US 55
* Microprocessor option with keypad for direct readout	$US 1,210
* Assorted transducers, cables, and mounting devices	$US 770 - 1320

Comments:
* Distributor is a division of Universal Ferro & Allied Chemicals LTD.
* Manufactured by Dynasonics Inc. USA

Ultrasonic Flow Meter

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact person: Madhusudhan, Director of Sales

Technical Specifications: ICC Model 113-002

* Measures fluid flow rate (0.5 to 20 ft/sec), totalizer 8 digits, liters
* Output: 4 to 20 amps
* Accuracy: +/- 5%
* Repeatability and linearity: +/- 0.1%
* For 15 to 2,000 mm pipe diameters
* Rechargeable battery power.

Price (provided Jan,9,95)

ICC Ultrasonic Flowmeter Model 113-002	Rs 77,101

Comments: Manufactured by ICC Federated of USA

Ultrasonic Flowmeter

Supplier: Jost=s Engineering Company LTD.
Registered Office
60 Sir Phirozeshah Mehta Road
Bombay 400 001
Phone: 91-22-286-1150 Fax: 91-22-294-601

Technical Specifications: Controlotron 990

* Permanent mount

Price (provided Jan,12,95)

994 MN4 GM3 computer	$US 6,575	Rs. 468,797
Transducer pair	$US 1,056	Rs. 75,292
Mounting track	$US 438	Rs. 31,229

Comments: Portable models are also available.

Other Sources of Ultrasonic Flow Meters

M/s Abhar Engineering
P. B. 34667, Anna Nagar
Madras 600 040
Phone: 91-44-621-5697 and 626-0552 Fax: 91-44-621-3285

5.4 Humidity and Temperature Meters

Description:
Most of the humidity meters included in the directory are electrical. Electrical humidity-measuring instruments use sensors which react to varying levels of humidity by causing a physical change in a material which changes its electrical properties (often resistance). The material=s electrical property is calibrated to humidity. Often thermocouples are used to measure temperatures. Thermocouples utilize materials whose resistance is indicative of temperature.

Application:
Given processes have optimal humidity and temperature conditions. For office, commercial, and residential settings, a humidity between 40% and 60% is considered optimal. Low humidity results in respiratory problems and static electricity problems which can damage delicate electric components. High humidities can cause mildew, wood warping, and poor drying.

Humidity and Temperature Meter

Supplier: Instrument Research Associates
Instruments House
P.B. No. 2304
19 Mysore Deviation Road
Gopalapuram, Bangalore 560 023
Phone: 91-80-330-0382 and 338-0996 Fax: 080-330-1969
Contact Person: A. L. Simha, Marketing General Manager

Technical specifications:
* Temperature range: 0 to 50^{o}C
* Resolution: 0.1^{o}C
* Accuracy: 0.5^{o}C
* RH range: 0.1%
* Accuracy: +/- 2%

Humidity and Temperature Meter

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 or 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical specifications:

* Simultaneous humidity and temperature measurement with LCD display
* Measuring range
  Temperature: -20 to 60ºC
  Humidity: 2% to 98%
* Factory preset C/F option

Comments: Manufactured by Hsin Huey Co. LTD., Taipei Taiwan

Temperature and Humidity Meter

Supplier: Instrument Research Associates
Instrument House
P.B. No. 2304
19 Mysore Deviation Road
Gopalapuram, Bangalore 560 023
Phone: 91-80-330 0382 and 338 0996 Fax: 91-80-330 1969

Technical specifications :

	Humidity	Temperature
* Measuring & controlling range:	30 to 95%	0 to 45ºC
* Resolution: -/+	1%	0.1ºC
* Accuracy: -/+	2%, 2 digits	0.2%, 1 digit

* Display: 3-digit, 7-segment red LED
* Power: 230 v, 50 hz, single-phase
* Weight: 0.7 kgs

Temperature and Humidity Recorders

Supplier: Instrument Research Associates
Instrument House
P.B. No. 2304
19 Mysore Deviation Road
Gopalapuram, Bangalore 560 023
Phone: 91-80-330-0382 and 338-0996 Fax: 91-80-330-1969

Technical specifications :

* Memory Capacity: 32 Kb
* Display: 3-**2** digits LCD
* Power source: 230 volts, 50 Hz, single-phase
* Weight: 0.7 kg
* Operating system: MS-DOS version 3.1 or higher
* Log interval: 5mts to 60 mts programmable

Comments: Seems to record data for the aforementioned temperature and humidity meter.

Other Suppliers of Humidity and Temperature Meters

Sulzer India LTD
9 B W Avenue
West CIT Colony, Madras 600 004

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 and 457-907

5.5 Light Meters

Description:
Light meters measure illumination or light level in units of foot-candles or lumens. Light emitted by the area of interest passes through a light-sensitive layer of cells contained in the meter. This light is converted to an electrical signal proportional to the light=s intensity. It differs from a conventional photographic light meter in that it is color- and cosine-corrected and measures lighting from a wide rather than a small field. Most lighting levels encountered during energy audits are less than 1,000 foot candles. (Note: 10.76 foot candles = 1 lux.)

Application:
Light meters are most commonly used to determine if interior lighting levels are appropriate, both before and after lamping upgrades are made. Lighting societies (e.g., the Illumination Engineering Society of North America) have developed guidelines for lighting levels for different work/interior areas. These guidelines were developed to minimize eye strain and maintain a safe environment, while not producing excess lumen levels and wasting energy. If lighting conditions are inappropriate, lumen levels should be adjusted.

Light Meter

Supplier: Electronic International
P.B. No. 385 New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272

Technical Specifications: AEMC Model 814
* Measures in foot candles or lux,
* 0 to 10,000 range
* Includes photocell and 1/10 reducing screen

Price (provided Jan,9,95)
AEMC Light Meter Model 814 Rs. 49,417

Comments: Manufactured by AEMC of USA

Light Meter

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272

Contact Person: Madhusudhan, Director of Sales

Technical Specifications: AEMC Model 2271F
* Measures in foot candles or lux
* 0 to 10,000 range
* Includes photocell and 1/10 reducing cosine correction screen

Price (provided Jan,9,95)
AEMC Digital Light Meter Model 2271F Rs. 49,417

Comments: Manufactured by AEMC of USA

Light Meter

Supplier: Jost=s Engineering Company LTD.
Registered Office
60 Sir Phirozeshah Mehta Road
Bombay 400 001
Phone: 91-22-286-1150 Fax: 91-22-294-601

Technical Specifications: Model LM 4
Measures 0 to 2000 lux

Price (provided Jan,12,95)
Light Meter model LM 4 $US 194.4

Light Meter

Supplier: Pulsecho Systems (Bombay) PVT. LTD.
110, Nirmal Industrial Estate, near Sion Fort
Sion (east) Bombay 400 022
Phone: 91-22-407-1055 and 409-2087 Fax: 91-22-407-4244

Technical Specifications: D-LUX
* Digital
* Range: 20,000 LUX, 20 kLUX, 50 kLUX
* Accuracy: +/-5%
* Sensor: photographic cell (10 x 25 mm)
* Response: visible light
* Center wavelength: 555 nm
* Response time: 3 to 5 seconds

Price (provided Feb. 13, 1995) Rs. 4,150.0

Other Suppliers of Light Meters

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 and 91-44-457-907

5.6 Multimeters

Description:
Multimeters measure amps (electron flow) volts (Aelectrical pressure@) and ohms (resistance) of electrical equipment. These metering abilities can also be purchased as separate instruments: ammeters, voltmeters and ohmmeters. Ammeters are used to measure electric currents. A voltmeter measures the difference in electrical potential between two points in an electrical circuit.

Multimeters, particularly the digital clamp-on designs, are considered the most versatile audit instrument. Analog instruments use a separate sensing circuit each to measure volts, amps, and ohms. Digital instruments transform the analog signals into binary signals which are counted and displayed in a digital format. The typical multimeter will measure 0 to 300 amps, 0 to 600 volts, and 0 to 1,000 ohms. The ability to measure Atrue RMS@, or root mean squared, voltage is vital when analyzing AC signals that may produce distorted wave forms.

Applications:
Multimeters are commonly used to check that the proper voltage is supplied to equipment, or to determine the load on a wire or electrical device (e.g., a motor). Multimeters are also used to determine if three-phase power supply is balanced. For example, a voltage imbalance of 3% at a three-phase motor can result in a 25% motor temperature increase, which reduces motor life and motor efficiency. A high-quality multimeter (or voltmeter) is required to determine voltage balance.

Multimeter

Supplier: Econ Consultants
D-10,Corner View
Plot No: 378
15th Road
Bandra, Bombay 400 050.
Phone: 91-22-648-683
Contact person: S. Giani, Managing Director

Technical specifications:
Model: Clamp-on Multimeter MX 1200 S
* Display: LCD-13 mm digit height
* Isolation: 6 kV - protection class II
* Power supply: 9V alkali - IEC 6LR 61(PP3)
* Dimensions: 250 mm x 90 mm x 65 mm

Multimeter

Supplier: MECO Instruments PVT. LTD.
Bharat Industrial Estate
T.J. Road
Sewree, Bombay 400 015
Phone: 91-22-412-4540 and 414-0786 Fax: 91-22-413-0747

Technical specifications:

* Various models of digital multimeters for measuring DC and AC voltage current and resistance
* Ranges
  - DC voltage up to 1,000 volts
  - AC voltage up to 750 volts
  - DC current up to 20 amps
  - AC current up to 20 amps
  - Resistance up to 20 mega-ohms
* Model 954,225 measures capacitance and inductance
* Ranges:
  - Capacitance up to 200 micro F
  - Inductance up to 200 H
  - Frequency 4 kHz to 2 MHz

Multimeter

Supplier: Process Technique Electronics PVT. LTD.
Sandylya 324
P.B. 1776, Konena Agrahara
Vimanapura Post, Bangalore 560 017
Phone: 91-80-526-9895 and 558-0106 Fax: 91-80-558-8098
Contact person: Siva S. Nagarajan, Executive Director

Technical specifications :

* Energy multimeter for measuring all parameters kWh, mWh, Hz, kVAr, etc.
* Signal by means of LEDs
* 1 to 1.5 % accuracy
* Can interface with a personal computer

Multimeter

Supplier: Motwane PVT. Ltd..
127, Mahatma Gandhi Road
P. O. Box 1312.
Fort, Bombay 400 023
Phone: 91-22-267-3845 Fax: 91-22-262-6969
Contact person: V. J. Mehta, Senior Sales Executive

Technical specifications :

* Measures amps, volts, kW, kVAr, kVA, power factor, phase angle, firing angle
* All measurements easily read of LCD display
* Operates continuously for up to 15 hours on a set of batteries
* Optional 120/240 volt AC adaptor is available for extended use

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Multimeters

Supplier: Hinditron/Tektronix Instruments Limited
No. 5, Crescent Road
High Grounds, Bangalore - 560 001
Phone: 91-80-226-5470 and 226-5471 Fax: 91-80-226-0669

Comments: Manufactured by Tektronix USA

Multimeters

Supplier: Hewlett-Packard India LTD,
Paharpur Business Centre
21 Nehru Place
New Delhi 110 019
Phone: 91-11-647-2311 and 647-2328 Fax: 91-11-646-1117

Technical Specifications:

* Measures AC and DC volts, current and resistance, possesses 1 kV DC, 750 VRMS and 10A
* 6-**2** digit
* Able to measure up to 1,000 volts
* 10 extended functions
* 15 ppm basic DCV accuracy
* 1,000 reading per second
* HP-IB and RS-232C.
* Hand-held

Comments: Manufactured by Hewlett-Packard USA

Multimeter

Supplier: Hinditron Services PVT. Ltd.
Hinditron House, 23-B Mahal INDL. Estate
Mahakali Caves Road
Andheri (E), Bombay 400-093
Phone: 91-22-836-4560 or 832-6590 Fax: 91-22-836-4682

Price (valid through Jan, 24, 1995)

Fluke 85, 3-3/4 digital Multimeter	Rs. 16,760
Calibration & verification charge	Rs. 1,500
AC/DC current probe up to 400 A	Rs. 10,250
Thermocouple Module	Rs. 5,130
Immersion Probe (-196 to 1090°C)	Rs. 3,740
Surface Probe (0 to 260°C)	Rs. 6,040
Piercing Probe (-196 to 816°C)	Rs. 4,440

Comments: Manufactured by Fluke USA

Multimeters (and Digital Clampmeter)

Supplier: Jost=s Engineering Company LTD.
Registered Office
60 Sir Phirozeshah Mehta Road
Bombay 400 001
Phone: 91-22-286-1150 Fax: 91-22-294-601

Technical Specifications:

Model M3006: 3 **2** digit, 2.25%, positive capacitance frequency and duty cycle
Model M3005: 3 **2** digit, 2.25%, positive capacitance frequency and duty cycle
Model DCM 1000 Digital Clampmeter: 220 amp DC/AC (also a power factor and watt meter)

Price: (provided Jan,12,95)

M3006	$US 439.2
M3005	$US 295.2
MCC 505 current clamp for M3005 and M3006	$US 264.8
DCM 1000 Digital Clampmeter	$US 758.4

Other Sources of Electric Multimeters

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 and 457-907

Comments: Manufactured in Germany by ITT

5.7 pH Meters

Description:
The pH of an aqueous solution is a value expressing the solution's acidity or basicity, based on the concentration of hydrogen ions present (where 0 is strongly basic, 14 is strongly acidic, and 7 is neutral). A pH meter uses the property of certain types of electrodes to exhibit electrical potential when emersed in a solution. The electrical potential is indicative of the solution=s pH. The instrument has three elements, an electrode or cell that measures pH, a reference electrode, and a resistance thermometer. (The thermometer is used to compensate for the effect of temperature on electrical potential.) Both electrodes are typically enclosed in thin-walled glass tubes. Inside the measurement electrode, is a solution of known pH. When the measurement electrode is placed in the unknown solution a voltage is generated. The reference electrode is then inserted into the unknown solution - providing a reference voltage. The voltages are compared and displayed on a calibrated pH scale.

Application:
Accurate measurements of pH are required to properly maintain water quality in order to protect equipment and materials that are in contact with the water (e.g., boiler tubes and heat ex-changers). Serious problems (e.g., precipitation of salts and corrosion) can occur if proper pH levels are not maintained.

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pH Meter

Supplier: Ion Exchange India Ltd.
42, B. N. Reddy Road
Madras 600 017
Phone: 91-44-825-3293 and 0897 Fax: 91-44-883-361
Contact person: T. V. Sriram, Sales Officer

Technical specifications :

* Type 45: wall-/site-mounted weatherproof indicator
* Type 40/96 & 40/144: Panel-mounted indicator/transmitter
* Type 41: portable indicator
* pH range: 0 to 14 and 2 to 12
* Redox potential: 700-0-700 and 500-0-500 MV

5.8 Watt Meters, Power Meters, and Power Analyzers

Description Watt Meter:
The watt meter is employed to directly measure the amount of power used by a single-phase electric device. The basic watt meter consists of two voltage probes and a snap-on current coil which feeds the watt meter's movement. It measures true RMS (root mean squared) voltage, current and power factor. Based on the current and voltage measurements, a watt meter calculates and displays power (watts) consumption. Multiple measurements using a watt meter can be used to assess three-phase circuits. The typical watt meter has operating limits of 300 kW, 650 volts, and 6,000 amperes.

Description Power Meter:
Power meters measure true RMS voltage, current, and the power factor and calculate power use by single-phase and balanced or unbalanced three-phase circuits. Some meters record a time history of the measurements.

Description Three Phase Power and Disturbance Analyzer
These meters can do everything that a power meter does and more. Power analyzers are used to determine parameters on the sine and nonlinear/distorted wave forms and harmonic distortion levels for both balance and unbalanced power systems. Many electronic devices cause harmonic distortions in both voltage and current waveforms. Because of these distortions, the measurements given by conventional power meters may be incorrect. Power analyzers compensaste for harmonic distortions by using RMS methods to determine voltage and current.

Application:
These instruments are very useful for testing, measuring, servicing, and maintaining electrical equipment and facilities. For example a watt meter can be used to measure the power consumption of an individual motor to determine if it is properly sized for its application

Power disturbance information provided by power analyzers is used to diagnose problems which can reduce electronic device reliability. For example, phase sequencing problems can cause sluggish or overheated motors (which results in premature equipment failure). Managing power quality prevents overloading conductors and minimizes the risk of problems resulting from voltage irregularities.

Watt Meter

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272

Contact Person: Madhusudhan, Director of Sales

Technical Specifications: AEMC Model 1800

* Measures 10 to 199.9 watts range
* Input voltage 90 to 560 VAC
* Input current 1 to 500 amps, frequency 50 to 400 Hz, phase angle error +/- 1 degree
* Includes:
  - 1000:1 standard current probe
  - three safety voltage leads
  - 2 current leads
  - battery

Price (provided Jan,9,95)

AEMC Model 1800 Power Factor Meter Rs. 53,546

Comments: Manufactured by AEMC of USA

Watt Meter

Supplier: Automatic Electric LTD.
570 Naigaum Cross Road
Wadala, P.O. Box 7103
Bombay 400 031
Phone: 91-22-414-6330, 6331 and 6333 Fax: 91-22-414-6254 and 415-4492
Contact person: K. V. Menon, Vice President of Sales

Technical specifications:

* Accuracy Class is 1.5 ºC
* Portable, low-power-factor water meter has a power factor range of 0.2-0.05
* Voltage range of 15 to 600 volts

Price Information :

1) Switchboard Instruments

Size	Potential Coil	Number of phase(s) / Number of elements	
mm	volts	Three / double	Three / Triple
96	110	Rs. 1,945	Rs. 2,355
96	440	Rs. 2,115	Rs. 2,520
144	110	Rs. 2,175	Rs. 2,645
144	440	Rs. 2,335	Rs. 2,800

2) Portable instrument vary from Rs. 3,455 to 8,320

Watt Meter

Supplier: Syntron Controls
Shiva Shakti
Naigum Road No. 2
Dadar, Bombay 400 014
Phone: 91-22-413-3268

Technical specifications :

* Available in both flush panel mounting and portable models
* Available for single and triple phases

Price Information:	Number of Phases/ Number of Elements		
number of digits	single/single	three/double	three/triple
3	Rs. 2,772	Rs. 3,528	Rs. 4,104
3 **2**	Rs. 2,790	Rs. 3,546	Rs. 4,122
4	Rs. 3,024	Rs. 3,780	Rs. 4,356
4 **2**	Rs. 3,042	Rs. 3,798	Rs. 4,374

Power Meter

Supplier: Bhoosan
24 Gururaj Society
137/4 Kothrud
Paud Road
Pune 411 029.
Phone: 91-212-332-3670
Contact person: K. R. Mundewadi

Technical specifications :

* Input: Voltage: 110 kV (For high tension), 230V (for single-phase) and 415V (for low tension) current from suitable current transformer with 5 amp secondary
* Size: 96 mm x 192 mm x 300 mm

Price Information:

Model	Cost
EASY 9102E	Rs. 25,800 plus extra charges
EASY 9102P	Rs. 40,500 plus extra charges

Power Meter

Supplier: Bhoosan
24 Gururaj Society
137/4 Kothrud
Paud Road
Pune 411 029.
Phone: 91-0212-332-3670
Contact Person: K. R. Mundewadi

Technical specifications :

* Input voltage: 433/415 v three-phase, 40-wire current from suitable current transformer with 5 amp secondary
* Size: 150 mm x 300 mm x 400 mm

Price Information :

Model	Cost
EASY 9101E9	Rs. 5,500 plus extra charge

Power Meter

Supplier: MECO Instruments PVT. LTD.
Bharat Industrial Estate
T.J. Road
Sewree, Bombay 400 015
Phone: 91-22-412-4540 and 414-0786 Fax: 91-22-413-0747

Technical specifications :

* Single-phase, three-phase analyzers indicate voltage, current, watts, and frequency
* Range:
  Voltage: 0 to 500 volts
  Current: 0 to 10 amps
* Accuracy: 0.5 % of indicated value + 5 digit
* Can be used for testing motors, transformers, TV sets, switch mode power supply, invertors, computers, etc.

Power Meter

Supplier: Alacrity Electronics LTD.
15 Thirumalai Road
T. Nagar, Madras 600 017
Phone: 91-44-825-1771 Fax: 91-44-825-9406

Contact person: D. S. Dwaraknath, Executive Director of Sales
Technical specifications:

* Displays 7 measurements on two screens
* The first screen displays volts, amps, power factor, and kW
* The second screen displays kVAr, kVA and Hz
* AC and DC measurements
* Measures true RMS values

Comments:

* Manufactured in collaboration with Elcontrol Energy, Italy
* Branches in Bangalore, Secunderabad, Coimbatore, and Kochi

Power Meter

Supplier: MECO Instruments PVT. Ltd.
Bharat Industrial Estate
T. J. Road
Sewree, Bombay 400 015.
Phone: 91-22-412-4540 and 414-0786 Fax: 91-22-413-0747

Technical specifications:

* Simultaneous display of three-phase voltage, three-phase current, actual wattage, apparent power, frequency, imaginary power, and power factor
* Programmable relay, on/off permissible for setting of delay time ranging 0-999 seconds
* Operating temperature: -10 ºC to 50 ºC
* Displays: display is complete with numeric data exchanged twice per second
* Acts as a power overload protector, reduces power consumption

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Power Meter

Supplier: Allen India, Ltd.
C-11 Industrial Area, Site 4
Sahibabad, Ghaziabad 201010
Phone: 91-11-877-1112 Fax: 91-11-877-0822
Contact person: Shoumitra Chatterjee, General Manager of Power Production

Technical specifications :

* Analyzes kW, kWh, kVA, kVAr, power factor, line frequency, 4 voltages, 4 currents
* Includes 16 BIT microprocessor-based architecture and I/O capability to replace traditional electric meters
* Outputs: 3 sets of SPDT (form C) user-configured analog output
* Operating temperature: 0 ºC to 50 ºC

Comments: Company Headquarters 1201 S. Second Street, Milwaukee WI 53204 USA.

Power Meter

Supplier: Motwane PVT. LTD.
127, Mahatma Gandhi Road
P. O. Box 1312.
Fort, Bombay 400 023
Phone: 91-22-267-3845 Fax: 91-22-262-6969
Contact person: V. J. Mehta, Senior Sales Executive

Technical specifications:

* Measures watts, AC Vars, kVA, demand and power factor
* Servo response 0.5 seconds to full scale
* Alarm option allows full range adjustable alarm with one set point for each channel
* Scaled for standard transformer having a ratio of 1,000 ampere primary to 1 ampere

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Clamp-on Power Meter

Supplier: Pinkcity Electronics PVT. Ltd.
F-39, Suresh Marg
C-Scheme, Jaipur 302 001
Phone: 91-141-38 Fax: 91-141-561492
Contact person: Mr. S.K. Verma

Technical specifications :

* Relative humidity < 80%
* Working temperature: 10 ^{o}C to 50 ^{o}C
* Power factor: from -0.00 (capacitif) to +0.00 (inductif)
* Voltage: 0 to 35 and 35 to 600 volts

Price Information: Rs. 40,000

Power Analyzer

Supplier: Electronic International
P.B. No. 385 New No. 524
Sampige Rd., Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact person: Madhusudhan, Director of Sales

Technical Specifications: AEMC Model 3930

* Measures kWh, kW, RkVAh, kVA, power factor, volts, amps, and harmonics
* With LCD display and printer
* Rechargeable
* 25 pin RS232 communication port
* 15 to 150 amps
* 100 to 1000 amp current transformers

Price (provided Jan,9,95)

AEMC Three-Phase Energy Analyzer Model 3930 133,384 Rupees

Comments: Manufactured by AEMC of USA

Power Analyzer

Supplier: Jost=s Engineering Company LTD.
Registered Office
60 Sir Phirozeshah Mehta Road
Bombay 400 001
Phone: 91-22-286-1150 Fax: 91-22-294-601

Technical Specifications: Pentaplus

120/240 volt, 50/60 Hz

Price (provided Jan,12,95)

Pentaplus Three-Phase Power Analyzer	$US 7,900
various leads	$US 200 to 380
various transformers	$US 530 to 1,100
carrying case	$US 300
Kodak ink jet printer	$US 419
printer adaptor	$US 40

Power Analyzer

Supplier: Emcon Instruments PVT. LTD.
58 First Main Road
CIT Nagar, Madras 600
Phone: 91-44-456-187, 434-1043 and 434-436 Fax: 91-044-434-5075
Contact person: M. Krishnamurthy, Managing Director

Technical specifications:

* Versatile microprocessor-based instrument for electrical energy management and equipment and installation cost savings
* Displays the parameters: three-phase voltage, three-phase current, power factor, active power, active energy, frequency, reactive power, reactive energy, and returned energy.
* Analog output: 4-20 mA 0 -20 mA
* Harmonic distortion analysis
* True RMS measurements through harmonic
* Improved man-machine interface
* Simple field system configuration

Other Sources of Watt Meters, Power Meters, and Energy Analyzers

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 and 91-44-457-907

Comments: Sell instruments manufactured by ITT of Germany

Merlinhawk Associates Pvt. Ltd.
134/1 Brigade Rd.
Bangalore 560 025
Phone: 91-80-227-7713 Fax: 91-80-227-5393
Contact person: Mr. A.G. Krishnaswami

Comments: Sell power analyzers manufactured by BMI of the USA.

5.9 Power Factor Meters

Description:
Power factor meters are used to measure the power factor of electrical equipment, particularly three-phase motors. Power factor is a measurement of the electrical current in a wire which is doing useful work compared to the total electrical current in the wire. The non-useful component of the current creates magnetic fields in the end-use device. These magnetic fields are not detrimental or beneficial to the end-use device. But the non-useful component of the current requires generation, transmission, and distribution capacity, thereby causing inefficiencies in power systems.

Power factor measurements indicate the phase shift between the voltage and the current. A perfect 90^{o} phase shift has a power factor of 1.0. If the phase shift is not 90^{o} , then a fraction of the current is not useful and the power factor is less than unity. The larger the phase shift, the lower the power factor, and the greater the power system inefficiencies. Power factor meters typically measure power factor over a range of 1.0 leading to 1.0 lagging and see Aampacities@ of up to 1,500 amperes at 600 volts.

Power factor meters can be used on single- and multi-phase electrical circuits. Multi-phase instruments simultaneously monitor all phases of voltage and current when determining power factor.

Application:
Once a power factor meter has been used to identify low power factors and the scale of the problem, capacitors can be installed to correct power factor problems by adding more capacity to the wiring network. (Power factor measurements are required to properly specify capacitor requirements.) With power factor improvement, the cost of power generation is reduced; utility power factor charges are reduced (if levied); and transmission, distribution, facility connection, and conductor size needs are reduced (as the I^2R losses are reduced).

Power Factor Meter

Supplier: Syntron Controls,
Shiva Shakti
Naigum Road No. 2
Dadar, Bombay 400 014
Phone: 91-22-413-3268
Contact person: P. S. Gokhale, Partner

Technical specifications :
* Available in both flush panel mount and portable
* Available for single and three phases

Price Information:

Number of Digits	Number of phases	Number of elements	Cost (Rs.)
1	Single	Single	3240
2	Three	Double	4095
3	Three	Triple	4770

Power Factor Meter

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical Specifications: AEMC Model 3900

* Digital meter
* Measures
  power factors of 0 to 1.0 lagging or leading
  voltage range 100 to 600, 50 - 400 Hz,
  current range 3 to 500 amps
* Includes 1000:1 current probe, three voltage leads, and battery.

Price: (provided Jan,9,95)
AEMC Model 1800 Power Factor Meter Rs. 53,546

Comments: Manufactured by AEMC of USA

Other Suppliers of Power Factor Meters

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 or 457-907

5.10 Ultrasonic Steam Trap Tester

Description:
Steam traps used in condensate return systems are typically designed to fail in the open position. In the open position, they pass high-energy-content steam directly into condensate return lines. An open steam trap is difficult to identify by visual inspection. Three types of steam trap testers have been developed to identify malfunctioning steam traps: infrared, conductive, and ultrasonic. Ultrasonic steam trap testers are the most popular and reliable. They operate as an "electronic stethoscope". They are able to pick up the very high-pitched sound indicative of freely blowing steam (condensate draining makes a lower-pitched sound). The advantage of ultrasonic testers is that they can listen to one pipe and hear if any of the nearby steam traps have failed.

Application:
Experts estimate that about 15 to 30 % of installed traps are faulty. Faulty steam traps are often the largest single source of energy losses at an industrial facility. Steam trap maintenance programs, where steam traps are regularly checked using an ultrasonic steam trap tester are typically very cost effective.

Ultrasonic detecting devices can also be used to identify any type of gas or fluid leaks (including steam, nitrogen, CFCs, compressed air, and fuel), leaking valves, line blockages, damaged motor bearings, malfunctioning compressor heads, and missing teeth on gears.

Ultrasonic Steam Trap Tester

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical Specifications: ICC Model 155-010
* Complete kit with headphones, 31-inch extension kit, SEMI transmitter, stethoscope and rechargeable batteries.

Price (provided Jan,9,95):
ICC Ultrasonic Steam Trap Tester Model 155-010 Rs. 59,487

Comments: Manufactured by ICC Federated of USA

Ultrasonic Steam Trap Tester

Supplier: M. K. Raju Consultants (P) LTD
16, Srinagar Colony
Temple Ave.
Madras 600 015
Phone: 91-44-235-2491 and 235-1151 Fax: 91-44-235-1070

Comments:
-Manufactured by Dawe of England
-M. K. Raju consultants is a firm which is willing to provide their customers with auditing equipment.

Other Suppliers of Ultrasonic Steam Trap Testers

Technovation Analytical Instruments PVT, Ltd.
4, Paramel
St. Cyril Road
Bombay 400 050
Phone: 91-22-640-0678
Fax: 91-22-644-3425

5.11 Stroboscopic Non-Contact Tachometers

Description:
A tachometer is an instrument used to measure the rotational speed of a shaft or wheel in revolutions per minute (rpm). A stroboscopic tachometer employs a variable-frequency, flashing light which makes the rotating component appear to stand still when the frequencies match. This allows the users to measure the rotational speed without contacting the object in question.

Application:
Stroboscopes are typically used to determine the mechanical loading of motors. By measuring a motor=s rpm and electrical consumption, its efficiency can be determined. Non-contact stroboscopes are also commonly used to measure fan speeds and determine fan output (using the design fan curve).

Stroboscopic Non-Contact Tachometer

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 or 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical specifications: Six models
* Bench top
* Speed ranges from 50 RPM to 20,000 RPM.
* Input configuration ranges from 1 pulse/revolution to 60 pulses/revolution
* Universal input, non-contact operation from optical, infrared, laser, proximity, and magnetic sensors
* Display: Analog
* Optional: LED

Technical Specifications for the Monarch Models DB 230 or DB 230 Kit
* Measures RPM (100 to 12,000 flashes per minute),
* Digital readout
* Dial adjustment
* Accuracy: +/- 1 flash/ minute
* Rechargeable battery

Price (provided Jan,9,95)

Monarch Stroboscopic Tachometer Model DB 230	Rs. 33,368
Monarch Stroboscopic Tachometer Model DB 230 Kit	Rs. 45,025

Comments: Manufactured by Monarch Instruments of USA

Stroboscopic Non-Contact Tachometer

Supplier: Pulsecho Systems (Bombay) PVT. Ltd.
Unit No. 110, Nirmal Industrial Estate
Near Sion Fort, Sion (E) Bombay 400 022
Phone: 91-22-407-1055 and 409-2087 Fax: 91-22-407-4244

Technical specifications:	Model	mP-TACH	STROBOLITE
* Auto range:		30 to 100,000 RPM	250 to 20,000 RPM
* Resolution:	+/- 0.1	30 to 2,000 RPM	+/- 1 RPM
	+/- 1	2,000 to 20,000 RPM	+/- 1 RPM
	+/- 10	>20,000 RPM	+/- 1 RPM

* Time base: Quartz crystal-controlled microprocessor
* Power: Four penlight batteries

Other Sources of Stroboscopic Non-contact Tachometers

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 or 457-907

Toshniwal Brothers (Hyd) PVT. Ltd
267, Kilpauk Garden Road
Madras 600 010
Phone: 91-44-613-076

Lawrence and Mayo (I) PVT. Ltd.
Scientific and Engineering Instruments Division
68, Anna Salai
Madras 600 002
Phone: 91-44-83-0312 or 83-0313

5.12 Non-Contact Infrared Thermometers *(also known as radiation pyrometers)*

Description:
These thermometers rely on the electromagnetic radiation emitted by solids or fluids. The radiation is characteristic of their temperature. A lens focuses the infrared energy on the active detecting surface. The heart of the infrared thermometer is the detecting surface, which absorbs infrared energy and converts it to an electrical voltage or current. The accuracy of temperature measurements by infrared instruments depends on the absorption, reflection, and transmission characteristics of the radiative flux. These instruments typically indicate thermal variations of 0.1ºC and can cover a range of -30EC to 2,000EC (5EF-3,600EF). Corrections to apparent temperatures are made from knowledge of the emissivity of the object at the specified temperature.

Application:
Non-contact infrared thermometers, also known as heat guns, are very useful for measuring surface temperatures of steam lines, boiler surfaces, processes temperatures, etc. The primary use of infrared sensors in an energy management program is to detect building or equipment thermal losses, pinpoint insulation or weatherization needs, identify electrical hot spots, and locate unseen motor friction points.

Non-Contact Infrared Thermometer

Suppler: CDCON
B -1 Shantivilla Apartment
Pratapkunj Society
Vasna, Ahmedabad 380 007
Phone: 91-79-432397 and 43070 Fax: 91-79-432397
Contact person: D. K. Soni

Technical specification :
* Quick response to 3,100ºF
* Measures moving material also
* Temperature can be measured from convenient distances
* Sensitivity of 1ºC

Price Information:

Options	Cost (approximate)
Soft case	Rs. 837.00
110 VAC adapter	Rs.1,007.50

Non-Contact Infrared Thermometer

Supplier: Electronic International
P.B. No. 385 New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical specifications:
* Temperature range: 0-3,000ºC
* Ambient temperature: 0-50ºC
* Digital emissivity adjustments: 0.2 to 1.0.
* Response time: 1 second
* Temperature display: Celsius or Fahrenheit.
* Focussing range: 12 inches to infinity
* Applications for energy auditing, maintenance and electronics industry

Comments: Manufactured by Irtronics Instruments USA

Non-Contact Infrared Thermometer

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 or 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical Specifications: ELAN Digitron D805HC
* Measures - 20 to 1,000ºC
* Accuracy +/- 0.3%
* 9 volt rechargeable battery,
* Target size at focal point, size ratio beyond focal point
* Adjustable emissivity.

Price: (provided Jan,9,95)
ELAN Digitron D805HC Rs. 47,833

Comments: Manufactured by ELAN of USA

Non-Contact Infrared Thermometer

Supplier: Masibus Process Instruments LTD.
B/30 G.I.D.C
Electronics Zone, Gandhinagar 382 044
Phone:91-2712-244-53 and 264-60 Fax: 91-2712-254-57
Contact person: K. Subramanian, Managing Director

Price information:

Model	Description	Costs (Rs.)
4002	Linearized Indicator	3200
4004	Portable	6500
40061	6 Channel Indicator	4500
40121	12 Channel Indicator	4900

Non-Contact Infrared Thermometer

Supplier: CDCON
B -1 Shantivilla Apartments
Pratapkunj Society
Vasna, Ahmedabad 380 007
Phone: 91-79-432397 and 43070 Fax: 91-79-432397
Contact person: D. K. Soni

Technical specifications:

Model	EM-100	IT-101	C-1600
* Temperature range (°F)	N/A	-20 to 2000	0 to 600
* Repeatability (+/-)	0.5%	0.5%	0.5%
* Response time (sec.)	1	1	1
* Dimensions (inches)	6 x 9 x 2.5	6 x 9 x 2.5	3.2 x 1.3 x 6.2
* Weight (lbs)	2	2	N/A
* Ambient operating range (°F)	0 - 110	40 - 110	40 - 110
Price Information (Approx. Rs.)	33,945	35,650	21,545

Non-contact Infrared Thermometer

Supplier: Jost-s Engineering Company LTD.
Registered Office
60 Sir Phirozeshah Mehta Road
Bombay 400 001
Phone: 91-22-286-1150 Fax: 91-22-294-601

Technical Specifications: Wahl Heat Spy: Model DHS-26X

* Temperature range (°F)	0 to 2,000
* Repeatability (°F)	+/- 2
* Response time (seconds)	1
* Accuracy @ 77 °F	+/- 0.3%
* Weight (lbs)	2.2
* Ambient Operating Range (°F)	25 to 125

Price (provided Jan,12,95)

DHS Digital Heat Supply Model 26X	$US 2,700

Other sources of Non-contact Infrared Thermometers

Microtek
40 A, First Floor
1st Main Road
CIT Nagar, Madras 600 035
Phone: 91-44-456-424 or 457-907

5.13 Contact Thermometers

Description:
Temperature is one of the most important properties determining the efficiency of thermal energy utilization. Several types of thermometers appropriate for energy auditing are available. The choice is usually dictated by cost, durability, range, accuracy, and application. Most HVAC applications require a thermometer with temperature of -50EC to 175EC (-50EF to 350EF). Boiler and oven stacks require thermometers able to meausre up to about 500EC (1,000EF).

Thermometer types include:

Fluid-filled instruments

These thermometers use either a fluid or solid which expands with increasing temperature. A very common design uses a simple calibrated and evacuated glass tube filled with mercury or alcohol.

Resistance Instruments

Electronic thermometers operate on the principle that some materials change their electrical resistance as temperature changes. Typically, the sensing element consists of a long, coiled, heat-sensitive wire wound about a ceramic core and protected by a metal housing. The material=s resistance is scaled to temperature and displayed.

Thermocouple Instruments

The operation of this class of thermometer is based on the response of two wires of dissimilar metals which, when joined together and heated, generate electricity. A very small DC voltage is produced across the ends of the wires. The resultant voltage is calibrated to temperature and displayed. Inespensive thermocouples typically measure temperatures up to 1,100EC (2,000EF).

Thermistor Instruments

These instruments utilize a solid-state semiconducting material which responds to temperature increases by decreasing the electrical resistance of the semiconductor. They are typically calibrated in the factory. A given current flow is indicative of a given temperature.

Application:
Temperature measurements are a useful method to determine process efficiencies (to assess appropriate heating levels, analyze boiler operation, and indicate building heat loss) and waste heat sources (determine the potential for waste heat recovery programs).

Contact Thermometers

Supplier: Instrument Research Associates
Instrument House
P.B. No. 2304
19 Mysore Deviation Road
Gopalapuram, Bangalore 560 023
Phone : 91-80-330-0382 and 338-0996 Fax: 91-80-330-1969

Technical specifications: Models 1000C, 1000M, 1000M and MXX SERIES
* Digital
* Display: 3 **2** digits
* Warm up time: instantaneous
* Sampling rate: 3 samples/second
* Ambient conditions: up to 50 °C
* RH: up to 95% non-condensing

Contact Thermometer

Supplier: Electronic International
P.B. No. 385 New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272
Contact Person: Madhusudhan, Director of Sales

Technical specifications: Models 305 and 306
* Digital
* Provided with K-type thermocouple
* Display: 3 **2** digit LCD with maximum reading of 1999
* Carbon zinc battery with 200-hour life
* Sampling rate: 3 times/second

Comments: Manufactured by Irtronics Instruments Inc., USA

Contact Thermometer

Supplier: Electronic International
P.B. No. 385, New No. 524
Sampige Rd. Near 11th Cross
Malleswaram, Bangalore 560 003
Phone: 91-80-334-0272 Fax: 91-80-332-3357 and 334-0272

Contact Person: Madhusudhan, Director of Sales
Technical Specifications: AOiP Models PN 6511, PN 6512 and PN 5613

* Digital
* Platinum RTD thermometer
* Temperature range -200 °C to 900 °C
* Resolution 1 degree or 0.1 °C
* Probe types immersion, surface, and needle

Price (provided Jan,9,95)

Model	Description	Price
PN 6511	RTD thermometer	Rs. 17,717
PN 6512	Enhanced RTD thermometer	Rs. 22,598
PN 5613	Differential RTD thermometer	Rs. 27,963

Comments: Manufactured by AOiP of France

Contact Thermometer

Supplier: Jost-s Engineering Company LTD.
Registered Office
60 Sir Phirozeshah Mehta Road
Bombay 400 001
Phone: 91-22-286-1150 Fax: 91-22-294-601

Price (provided Jan,12,95)

Digital Contact Thermometer Model: TCM 312	$US 7,900
TCL 309 handle and immersion probe	$US 66
TCL 301 general purpose probe	$US 53
TC 817 penetration probe	$US 150

Contact Thermometer

Supplier: Chroma Electronics
253 Matru Prena
Hingwala Lane (extension)
Ghatkopar (E), Bombay 400 077
Phone: 91-22-513-9259
Contact person: Paresh Bhatia

Technical specifications:

* Digital
* Range: 0 °C to 1,200 °C
* Accuracy: Better than 1% of full scale
* Power supply: 230 volts ,50 Hz AC

* Depth behind panel: 160 mm
* Output: one set of change over relay contacts rated at 5 amps at 230 volts AC

Price Information: Rs 1,300 plus extra charges

Contact Thermometer

Supplier: Hicks Thermometer LTD
A-12,13 & C-26 Industrial Estate
Aligarh, Pincode 202 001
Phone: 91-571-21238 and 28434 Fax: 91-571-401176, 401160 and 401260
Contact person: Mr. R. K. Singh, Assistant Sales Manager

Price information :

Model	Description	Max. Retail Price (Rs.)
HT-747	Digital thermometer	259
HT-707	Digital II thermometer	220

Contact Thermometer

Supplier: Instrument Research Associates
Instrument House
P.B. No. 2304
19 Mysore Deviation Road
Gopalapuram, Bangalore 560 023
Phone: 91-80-330-0382 and 338-0996 Fax: 080-330-1969

Technical specifications :

	Model		
Features	1000MCX	2000MCX	3000MCX
Temperature range (°C)	0-1270	0-1270	0-1270
Resolution (°C)	0.1 & 1	0.1 & 1	0.1 & 1
Accuracy (+/-)	0.5	0.5	0.5
Type	On/off	On/off	PID controllers

Contact Thermometer

Supplier: Selectron Process Controls
E-120 Ansa Industrial Estate
Saki Vihar Road
Andheri (E), Bombay 400 072
Phone: 91-22-578-6882 and 578-7443 Fax: 579-0733

Contact person: Samir Kaji
Technical specifications :

* Supply voltage: 110 Volts AC, 50/60 Hz
* Mechanical life: 10^6 operations
* Thermocouple sensors: J(Fe-k), k(Cr-Al), R(PT-Pt 13% Rh), S(PT-Pt 10%Rh).
* Temperature range: 0 °C - 1,600 °C
* Accuracy: 2.0% of full scale (setting)
  0.5% of full scale (control)

Price Information:

Mini temperature controller	Rs. 1,002
Temperature controller with deviation	Rs. 1,225

Contact Thermometer

Supplier: Switzer Instrument LTD
14 Thanikachalam Road
P.B. No. 1423
T. Nagar, Madras 600 017
Phone: 91-44-652-244 and 652-255 Fax: 91-44-625-8739
Contact person: B. Kannan, Marketing Director

Technical specifications :

* Range: -100 °C to 800 °C
* Lead resistance: 4 wires or 3 wires with integral automatic compensation and lead mismatch of 4 ohms maximum.
* 4-20 MA output
* Accuracy: 0.2 % of span inclusive of linearity at 30 °C

Price Information: Rs. 1,300 plus extra charges

Contact Thermometers

Supplier: : Technovation Analytical Instruments PVT. LTD.
4, Paramel St.
Cyril Road
Bandra, Bombay 400 050
Phone: 91-22-640-0678 Fax: 91-22-644-3425
Contact person: E. D. D=Sylva, Chief Executive

Technical specifications: Hand-held digital thermometer

* Digital
* Hand-held

* Sensors are Cr/Al thermocouples
* Temperature Ranges:
    Using
    Flue gas 300 mm-long probe 0 - 600°C
    Hot gas 450 mm-long probe 0 - 1,100°C
    Spring-loaded surface probe 300 mm long 0 - 350°C
* Resolution: 1°C
* Accuracy: better than +/- 1% of full scale
* Response time: less than 25 seconds
* Power supply: 9-volt battery

Comments: Manufactured in India

Other Suppliers of Contact Thermometers

M/s Microsensors
No. 5 Karani Garden Main Street
Saidapet, Madras 600 015
Phone: 91-44-485-0655

Appendix 1
Business Support Services: U.S.

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Business Support Services: U.S.

(This section is largely excerpted from US&FCS, 1994)

The U.S. Department of Commerce, the U.S. and Foreign Commercial Service (US&FCS), and U.S. Embassies in India seek to promote U.S. investments which enhance the export of U.S.-origin goods and services to India. U.S. government commercial and trade promotion services include:

- Embassy officers in the Economic and Commercial Sections can provide client-confidential advice and counsel to interested U.S. firms. For more information, please contact the U.S. Embassy or one of the U.S. domestic offices of the U.S. and Foreign Commercial Service (listed in the government pages of your telephone directory). The Commercial Office at the American Embassy in New Delhi (phone number 91 11 600 651 and fax number 91 11 687 2391) will provide information on upcoming trade fairs and business opportunities to interested U.S. firms.

- U.S. firms considering entering or increasing their sales in the Indian market find participation in events sponsored by the U.S. Department of Commerce and the U.S. and Foreign Commercial Service (US&FCS) in India to be excellent vehicles for promoting business in India. Interested firms should contact the Office of South Asia (telephone: 202-482-2954 or fax: 202-482-5330) at the U.S. Department of Commerce, International Trade Administration, Washington, D.C.; the nearest district office of the U.S. International Trade Administration (located in major cities and listed in the U.S. Government pages of the telephone directory); or the US&FCS offices at the U.S. Embassy in New Delhi, one of the U.S. Consulates General in Bombay, Calcutta, or Madras, or the US&FCS field office in Bangalore.

- US&FCS India offers an agent distributor service for a user fee of US$ 250 per post. On the basis of information provided by the U.S. client, a commercial specialist with industry expertise seeks to match the business interests of an exporter with three or more potential candidates. Will provide a snapshot description of the market, identify the Indian firms who have expressed interest, and give an evaluation of their strengths and weaknesses. The Agent Distributor Service is a customized overseas search for qualified agents, distributors, and representatives for U.S. firms. Can produce up to six foreign prospects that have examined the U.S. firm's product literature and expressed an interest in doing business in India.

- US&FCS India offers a World Traders Data Report (WTDR), a means of checking the reputation, reliability, and financial status of prospective Indian trading partners. Information in a WTDR includes type of organization, year established, product lines, size, business reputation, principal owners, financial and trade references. A recommendation from the nearest US&FCS office as to the suitability of the Indian company as a trading partner for a U.S. firm is included. The user fee for this report is US$ 100 as of June 1994.

Business Support Services: India

India's private businesses are organized into three leading business organizations. These organizations should be contacted by firms interested in entering the Indian market.

$ Associated Chambers of Commerce (ASSOCHAM)
ASSOCHAM is the oldest national organization of the Chambers of Commerce in India. It is non-political, seeking a close working relationship with the government and representative business and commercial organizations.

$ Confederation of Indian Industry (CII)
The CII has more than 2,000 corporate members whose total capital investment is over US$ 33 billion. CII members include public enterprises (Oil & Natural Gas Corp., Gas Authority of India, Ltd., Steel Authority of India Ltd.) as well as the major private business houses of India. The CII organizes trade fairs, conferences, and meetings. It has signed a Memorandum of Understanding with the U.S. National Association of Manufacturers.

$ Federation of Indian Chambers of Commerce and Industry (FICCI).
FICCI was established in 1927 as a central organization of industry, trade, and commerce in India. The Government has invited FICCI to join over 100 advisory bodies for policy review and recommendation. FICCI organizes trade fairs, conferences, and workshops to serve its members. FICCI has a longstanding relationship with the U.S. Chamber of Commerce (Washington, D.C.).

$ The Indian Trade Promotion Organization - located in New York City, phone (212) 753-6655 and fax (212) 319 6914.

Appendix 2
A Guide to Current Import Tariffs

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A Guide to Current Import Tariffs

A guide to current import tariffs, arranged by their Indian AHarmonized Schedule numbers@, is available from:

Chief Controller of Imports and Exports
Ministry of Commerce
Udyog Bhawan
Maulana Azad Road
New Delhi 110 001
Telephone: 91-11-301-1938 or 301-1275

The India Desk at the U.S. Department of Commerce (Washington, D.C.) may also be able to give you the specific rate of duty if you know the HS number for your product.

Telephone: (202) 482-5149 Fax: (202) 482-5330.